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MEADOWS AND PASTURES:

FORMATION AND CULTIVATION IN THE MIDDLE EASTERN STATES.

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BY

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF AGROSTOLOGY,
Washington, D. C., January 17, 1899.

SIR: I have the honor to transmit herewith a revised and corrected copy of Farmers' Bulletin No. 66 entitled "Meadows and Pastures: Formation and Cultivation in the Middle Eastern States," by Jared G. Smith, Assistant Agrostologist, and to recommend its publication.

The annual production of forage and fodder crops in the seven Middle Eastern States—Pennsylvania, New Jersey, Delaware, Maryland, Virginia, West Virginia, and North Carolina—amounts to more than 20,000,000 tons, valued at fully $150,000,000. The markets of the city of New York alone consume over 430,000 tons of hay per annum, an increase of 60,000 tons for 1898 over previous years. There has been a proportionate increase in the sales of hay in nearly all of the great commercial cities of the East, and the demand for it will probably continue to grow with the improving trade conditions in other lines. Improved methods of cultivation and the selection of the varieties best adapted to the soils of this region are therefore of the greatest importance to the farmer.

Respectfully,

F. LAMSON-SCRIBNER,
Agrostologist.

Hon. JAMES WILSON,
Secretary of Agriculture.

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MEADOWS AND PASTURES: FORMATION AND CULTIVATION IN THE MIDDLE EASTERN STATES.

INTRODUCTORY.

The average daily consumption of hay in the New York markets for a number of years has amounted to 1,000 tons, but during the last six months of 1898 the daily average has risen to 1,200 tons. The same improvement in the hay market has occurred in Boston, Philadelphia, Baltimore, and all other great commercial centers of the East. The export of hay from New York for the last week of December, 1898, amounted to 9,559 bales as against 3,188 bales in the last week of 1897, The increased demand for hay in the cities is a direct result of the increase in trade. The opening up of the markets in Porto Rico and Cuba and the requirements of the increasing shipments of live stock to European markets are among the factors which have caused this improvement in the hay market.

While it is the opinion of dealers that the best qualities of hay are no longer produced in the States bordering on the Atlantic coast, but come from the newer soils of the central prairie region, yet it is a fact that with equal care and attention as good hay as has ever been produced can yet be grown in these States. The acreage of meadow lands has decreased during the past decade in New York and the New England States. The acreage is rapidly increasing in the South. Farmers who have lands adjacent to, or within an easy distance of, the Eastern cities have an advantage over farmers in the West in the matter of freights, which often more than counterbalances the superior yields and quality of western products due to richer and newer soils. The causes which have led to the improvement in the hay market in New York City are operating throughout the country, and now is the time for farmers in the East to take advantage of the improvement in conditions and sow a greater acreage of the best meadow grasses.

GENERAL PREVALENCE OF GRASSES.

From the sand dunes along the coast to the utmost limits where flowering plants will grow, either upon the tops of high mountains or within the frigid zones, grasses are ever present in many forms and

varieties, each kind suited to some particular soil, climate, or natural condition. In the countless millions of individuals, grasses surpass all other families of plants. Grains, the product of the cereal grasses, form the staple food of more than four-fifths of the human race. Rice is a grass. Indian corn, wheat, barley, oats, and sugar cane are grasses. These and many others are of the most direct importance to mankind.

COMMERCIAL VALUE OF GRASSES.

The commercial importance of grasses and clovers in relation to the profitable production of farm animals is very great. The figures of the Division of Statistics show that in the group of States embracing Pennsylvania, New Jersey, Delaware, Maryland, Virginia, West Virginia, and North Carolina there were on January 1, 1898, in round numbers, 1,346,000 horses of all ages, valued at about $62,123,000; 218,000 mules, valued at $12,426,000; 2,003,000 milch cows, worth $53,014,000; 1,658,000 oxen and other cattle, worth $32,368,000; 2,089,000 sheep, worth $6,000,000, and 4,297,000 swine, worth $19,041,000; the total number of all farm stock in these seven States amounting to 11,611,000 head of all classes, valued at $184,972,000. These 11,611,000 head of farm stock require for their maintenance upward of 20,400,000 tons per annum of all classes of forage and feeding stuffs, worth more than $150,000,000. The seven States named are not great stock-growing States. They rank in the aggregate of the combined values of live stock barely 20 per cent above that of Iowa alone.

Of the 20,400,000 tons of forage consumed each year, fully two-thirds must be grown on the farm in the form of hay, stover, silage, pasturage, clovers, and soiling crops, while much less than one-third is fed in the form of condensed foods, as grain, bran, oil cake, linseed and cotton-seed meals, and various milling wastes and by-products, a part of which may be locally produced. The figures concerning the enormous amounts of forage required are based upon Wolff's Tables. A milch cow of 1,000 pounds, live weight, consumes about 4¼ tons of dry fodder in one year. Every sheep of 50 pounds, live weight, eats from 360 to 410 pounds of dry matter in one year. Every thousand pounds of live pork consumes from 4.3 to 7.6 tons of dry feed in one year. Every thousand pounds of live horse flesh requires 3.8 to 4.4 tons of hay and grain to produce it. Such being the demands of our live stock, how are the necessary supplies to be produced at the greatest profit and least cost? The problem of how to cultivate the required grass, clover, and other forage becomes thus an important one, of prime interest to all farmers who have live stock to feed or a market for their produce. But, without considering the direct profit that accrues from growing grasses and clovers, soiling crops, and ensilage crops, there are excellent reasons why meadows and clover fields should be on every farm.

GRASSES AS SOIL BUILDERS.

Grasses are soil builders. They are the agents employed by nature to cover bare spots, to protect lands from the washing of torrential rains, and from the baking, burning, and sterilizing action of the sun, and finally to make the soil fertile. Wherever the natural conditions are sufficiently favorable to admit of the growth of any green plant the surface soil is first covered and protected by grasses. They are the agents that serve to build up fertile beds of loam. They gradually form turf, and the rotting turf makes humus, which is, from an agricultural standpoint, the most important and most valuable constituent of the soil. The presence of humus in a soil is a necessity. The richest soils, those that can sustain continued cropping the longest without the addition of artificial manures, are those that are rich in humus.

FUNCTIONS OF HUMUS IN THE SOIL.

Now as to the functions of humus in the soil. It acts first as an absorbent of moisture. A soil containing a high percentage of humus will soak up more water and will hold it longer than a soil deficient in organic matter. It changes the physical condition and gives that fineness and tilth so characteristic of a rich soil. It makes the soil less susceptible to abrupt changes of temperature, absorbing and radiating heat more slowly. The humus takes up nitrogen, phosphoric acid, potash, lime, magnesium, sulphur, and other inorganic plant foods, thus retarding the loss by leaching of soluble compounds. Through the action of minute forms of plant life which live in the soil the humus is finally attacked and broken down, and the plant foods are gradually released in such form that they can be readily absorbed by the roots of the growing crops. There is more "life" in a field of turned and rotted turf than in an equal area of long-cropped soil which has been abundantly supplied with the best of commercial fertilizers, but which is deficient in organic matter. Turf is indirectly a valuable reservoir of nitrogen, and to cover a field with turf-forming grasses is one of the best ways of increasing the amount of humus in the soil.

CLOVERS AND BEANS AS SOILING CROPS.

The clovers and beans are "fixers" of nitrogen, and are indispensable as soiling crops and as green manure. Both the grass crop and the clover crop draw less heavily upon the mineral fertilizers in the soil than do the more strongly feeding grains and root crops, and while they are taking less from the soil they are adding much organic matter to it. A farmer can add every year an amount of available inorganic phosporic acid and potash and nitrogen necessary to make his crop, but if the store of humus is not kept up the fertility will not increase from year to year as it ought.

GRASSES AND CLOVERS PROFITABLE CROPS.

The farms of the seven Middle Eastern States under discussion are admirably situated as regards proximity to market. At their borders or within easy reach are many of the great commercial centers, with millions of urban customers for every kind of agricultural product. A better market could not be desired. There is money in raising grasses, clovers, and forage plants, because these products are readily converted into beef, mutton, pork, wool, butter, milk, and cheese, which are always salable at good prices when of good quality. There is money in growing grasses and clovers because they enrich the land and make it more fertile.

FERTILIZERS FOR GRASS LANDS.

The improvement of farm lands by the cultivation of grasses alone without the aid of other thorough cultivation, or without the use of barnyard manures and commercial fertilizers, would be a slow and tedious process. The land would improve, but it might take half a lifetime to recover the full measure of its original fertility. The indispensable humus may be supplied gradually, or it may be rapidly increased by the judicious use of farm manures, clovers, cowpeas, vetches, peas, alfalfa, or any crop that will yield a large bulk of organic matter.

COMMERCIAL MANURES.

The subject of commercial manures for grass lands is one on which there is much difference of opinion. So many factors enter into the problem that it is quite impossible to recommend any hard and fast rules as to what to use, how much to apply or when to apply it. We can only state what has been found good for certain soils and certain crops. Soils differ widely in their composition, physical and chemical, even in adjacent parts of the same field, and hence their needs are extremely varied. Pasture lands and hay meadows require different treatment. Land deficient in lime or rich in lime, clay soil and sandy soil, upland and lowland, must each be fertilized according to its needs and the requirements of the crop to be grown. The general theory in fertilizing is this, that certain amounts of the essential elements, nitrogen, potash, and phosphorus, must be supplied at the time when needed, and in an available or soluble form. Nitrogen is the most important and at the same time the most expensive. It is also the least stable, and hence should be applied only at such times as it is needed and in quantities no greater than can be used by the crop.

Except in the case of moist soils rich in lime, the use of too much nitrogen at one time is an extravagance, for the surplus rapidly leaches out, or decomposes and passes into the air in the form of ammonia. There is a considerable amount of nitrogen in barnyard manure, and

where this is available, as in the neighborhood of towns and cities, it is often the cheapest source of nitrogen and humus. Other sources of nitrogen are ground bone and bone meal, fish scrap, tankage, dried blood, bran, cotton-seed meal, and peanut meal, and leguminous plants such as clovers, vetches, and beans grown as green manurial and soiling crops. Nitrate of soda is often recommended for grass lands, but is expensive, and so readily soluble that a single hard rain may wash out in a few hours all that has been applied to the land. Bad results follow its use when too large an amount is applied. It has been found by experiment that an application of nitrate of soda does not have much influence on the total amount of nitrogen in a crop of clover or peas, so that in the case of either of these crops a heavy application of nitrogenous fertilizer is undesirable. In growing hay for market, bone meal and tankage certainly increase the yield very materially. Ground bone is immediately valuable, not, as has been generally believed, for its content of phosphoric acid, but for its nitrogen, which is in such form that it becomes gradually available during several months, and so acts as a continuous stimulant to the growing crop. Cotton-seed meal has much the same effect, and where it can be obtained at reasonable rates is a good substitute for bone. Tankage, fish scrap, and dried blood are all rich in nitrogen, and nearly approach bone and cotton-seed meal in chemical composition and effect on the growing crops.

Phosphoric acid may be best applied as superphosphate or acid phosphate. Fertilizers containing potash are wood ashes, cotton-hull ashes, kainit, muriate of potash, and ground tobacco stalks. In a clay soil deficient in humus, the surplus of either potash or phosphoric acid does not leach out in the same way as a surplus of nitrogen would, but enters into combination with the clay and is held for the benefit of future crops. Upon the addition of organic matter, lime, or salt to the soil, this surplus of potash and phosphorus is gradually broken down and is again transformed into soluble plant food.

In soils that consist of almost pure sand, with very little clay or organic matter intermixed, there must be frequent applications of small amounts of fertilizers, never putting on the field more than can be utilized by the crop before it has time to be washed and leached out of the soil. On such lands, when it can be cheaply obtained, crushed cotton seed from which the oil has not been extracted is better than cotton-seed meal, the oil acting to retard the rotting of the seed and thus extending the period of usefulness of its nitrogen.

METHODS OF PREPARING THE SOIL.

The first requisite in starting a permanent meadow is to have the land in good condition. A good meadow ought to last from four to six years and yield an average of three or four tons of hay per acre each

year. To get such results it is necessary to put the ground in the very best condition before sowing the seed. In the case of a field of corn, potatoes, or cotton, the crop receives numerous cultivations during the growing season, and the upper soil layers are constantly stirred and loosened to admit air and water. In preparing a field for grass, all of this stirring and mixing and opening of the soil must be done before the seed is planted, and enough of it must be done to last through the full term of years. All weeds must be got rid of before the grass seed is planted, because there is no satisfactory method of cleaning the weeds out of a meadow, except that of breaking up the sod and reseeding. A fall seeding is most desirable, because the grass may then follow a grain crop, and the soil after plowing may be harrowed and stirred until the weed seeds are all brought to the surface, germinated, and destroyed. The land should be plowed deep, from 6 to 9 inches, and the subsoil should be loosened with a bull tongue or other subsoiling plow to an additional depth of from 6 to 12 inches. Thus the soil will be thoroughly loosened to a depth of from 12 to 21 inches without turning down the rich surface layers or turning up the sour and sterile subsoil, which is unfit for sustaining plant growth.

The chief advantage of deep plowing and thorough preparation of the seed bed is the consequent thorough aeration of the soil. If available, a large amount of composted barnyard manure should be applied before plowing. Where the meadow is to be a permanent one, a dressing of from 20 to 30 tons per acre of barnyard manure, or as large an amount as is available, may be profitably applied. This seems an enormous quantity to recommend, and would be too expensive were the crop to occupy the land for only one year; but, considering the term of years through which the influence of this amount of organic fertilizer will extend, it will not prove wasteful in the long run. The common method of sowing grass seed with small grain is not a profitable one. It never pays to try to grow two crops on the same land at the same time. Each takes something from the other. All know that when sown with grain the grass crop often fails to catch. The tender young grasses are overshadowed by the nurse crop, and are just as effectually robbed of air and sunshine as if the crop of weeds were grown for protection. The best way is to grow the grain and grass crops separately. The grasses are, unlike the clovers, surface feeders, and thrive best and make the most luxuriant growth when the surface soil is heavily enriched. The deeper the preliminary cultivation and the larger the amount of stable manure or green manure that can be applied to the meadow the greater will be the annual yield and the longer the period during which the meadow may be profitably mowed without breaking up the sod and reseeding.

After plowing, which may take place as early in summer as the ground is free from the preceding crop, the field should be harrowed and reharrowed until the surface soil is worked fine and every weed

which has sprung up since the ground was broken has been destroyed. If the farmer does not have the necessary subsoiling plows and can not stir his field to the depth of 12, 18, or 20 inches, the next best thing is to plow it as deeply as he can and to make up for deep plowing by thorough mellowing and pulverizing as deep as his turning plows and cultivators will go. It is folly to sow the tame grasses on poorly prepared land, and, worse than that, it is a waste of good seed. The difference between good and thorough preparation, on the one hand, and shallow plowing and scanty harrowing, on the other, serves as a very good indication of what the yield and the profits will be. The best of seed, of the best varieties, planted on poorly prepared land will give only moderate yields for one or perhaps two seasons. If the same seed had been sowed on a field which, previous to seeding, had been given a deep plowing and the surface thoroughly harrowed and mellowed for the reception of the seed, not only would the yearly yield be larger and the profit greater, but the profitable life of the meadow would be extended through several seasons. The greater cost of good cultivation is thus all concentrated in the first year, and a yield of 4 tons of hay per acre the first season will cover it. The average yield of hay throughout the middle East does not exceed 1½ tons to the acre, but under this method of intensive farming, where more attention is paid to the preparation of the seed bed, and where the farmer gives to his hay meadow the same care as to his orchard, or to his onion or potato crops, yields of from 4 to 6 tons of hay per acre for half a dozen years in succession have been obtained.

Low-lying, cold, and heavy clay soils should be well drained, and if the field is at all swampy there should be a liberal application of lime to improve the texture of the soil and correct any acidity which may be due to the water having driven out all the air. Some form of potash salts should also be applied, as newly reclaimed swamp lands are always deficient in this fertilizer. There are many grasses which will grow on wet soils, but few that will thrive where there is stagnant water. To get the best results there must be a circulation of water in the soil. Hence the surplus should be carried off by drainage. The application of lime helps materially. Besides improving the physical condition of the soil, it unites chemically with decaying vegetable matter and preserves certain valuable plant foods which otherwise would be leached out and lost.

Fallowing and the plowing under of heavy crops as green manure are no longer considered the best and most profitable methods of farming. Turning under large amounts of succulent green forage often proves positively injurious by causing the soil to burn, or sour, through the rapid formation of organic acids. Moreover, there is much needless waste of valuable forage, which might be used to better advantage if it were fed to farm animals. *The feeding value of any forage crop is greater*

than its fertilizing value. When a crop is pastured or is cut and fed in the stable instead of being turned under green, there are two sources of profit to the farmer: (1) The gain in weight or in milk production of the animals fed, and (2) the fertilizers which are returned to the soil. A crop of grass or clover pastured or cut for hay and fed on the farm will not only suppert enough farm animals to pay for the use of the land, but when the grass sod or clover stubble is finally turned under there will be a large addition to the amount of organic matter in the soil and a resulting increase in fertility due to this fresh supply of humus. *The clovers are of great value on the farm, and whether they precede grass, grain, tobacco, or potatoes, the most profitable results are to be obtained by feeding them instead of turning them under as green manure.*

SOWING THE SEED.

Having put the seed bed in the best possible condition, the grass seed should be sown broadcast without a nurse crop. The field should be gone over twice, in two directions, using half of the quantity each time, so that an even seeding may be secured. The ground is then dragged with a light brush harrow and finally rolled. The use of the roller is very important. The packing of the dirt around the seed insures a higher percentage of germination, and the firming and packing of the surface soils prevents the rapid escape of water and hence loss by the drying out of the seedlings.

As in the cultivation of other crops, the quality of the seed has much to do with the success or failure of a meadow. Grass seed as purchased from seedsmen is expensive and sometimes of poor quality, but we believe that many of the failures in establishing meadows, lawns, and pastures have been due as much to the poor preparation of the seed bed, to sowing the seed on lumpy ground when it was too dry or too wet, as to the inferior quality of seed.

Grass seeds are mostly small; they germinate readily and rapidly at the right temperature and in the presence of sufficient moisture. The young seedlings are very quickly affected by abrupt changes of temperature. They require sufficient moisture and an even temperature to make their best growth. No hard-and-fast rule can be made as to the best time to sow grass seeds, and there is wide variance in practice. It is, of course, useless to sow unless the ground is moist; so that the time will depend much upon the season, whether it be August, September, or October. The seeding should be late enough to escape the intense midsummer heat and drought and early enough to allow the seedlings to get well established before severe cold weather sets in. In the North, where the rate of annual precipitation is high, the change from winter to summer is gradual, the winters long and severe, and the growing season short, spring sowing is often better than autumn; but farther South, where the change from winter to summer

is more abrupt, it is better to sow the seed in autumn, so that the young plants may have the advantage of such growing periods during the winter as will enable them to become well rooted and withstand the spring droughts. Spring seeding on land which is at all weedy does not pay, because the weeds choke out a great deal of grass. The best treatment of a weedy field would be to plant some hoed crop and get rid of the weeds before trying grass.

In some parts of New England, where the winters are severe, an autumn seeding can be secured by planting oats with the grass. The oats make a rapid growth and are then completely killed by the frost, and thus form a mulch to protect the young grass seedlings.

VARIETIES OF GRASSES AND CLOVERS TO PLANT.

The most commonly cultivated grasses in the Eastern States are timothy, orchard grass, redtop, and Kentucky bluegrass, or June grass. It would be hard to find a farmer who did not know and recognize these, and yet there are comparatively few who have ever tried to grow one of the dozen or more valuable grasses which are being constantly recommended by seedsmen and by experimental agriculturists. Nearly all are familiar with white, red, crimson, and alsike clovers, alfalfa or lucern, the cowpea, and the soy bean, but many farmers are equally uninformed as to the merit of numbers of species which are well known and widely cultivated in Europe. Besides these foreign grasses and forage plants there are many native species which might be profitably grown.

There are a greater number of native grasses in North America than in any other one continent, and there are as many in the United States as in Europe and Asiatic Russia combined. There are more than 200 native clovers, vetches, and lupines, none of which have been brought into cultivation on an extended scale. Many of these native grasses are undoubtedly equal to those grasses which have been introduced into cultivation because of their commonness, or perhaps because their seeds were conspicuous or easily gathered. The native species have the advantage over the introduced ones of being acclimated. They are perfectly adapted to those situations where they naturally grow, and need not be immediately replaced by introduced sorts. There is need of every farmer's taking an interest in the wild grasses and forage plants of his farm; there is no doubt that the cultivation of the best of the wild kinds would benefit him, both directly in helping to fill out the grass crop and indirectly by producing new crops which would have money value. All the cultivated cereals and grasses originated from small beginnings, from a few seeds gathered in a meadow or by the wayside, which were taken care of and cultivated for a number of successive years on an ever-increasing scale. It is work that can be done by the practical farmer as well as by the experimental agriculturist.

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HAY GRASSES.

Although the most commonly cultivated hay grasses are timothy, red-top, and orchard grass, yet there are a number of other species the cultivation of which might be profitably undertaken for special soils and special purposes, as will be seen from the following list:

Timothy (*Phleum pratense*, fig. 1).—This is the most widely cultivated of all the tame grasses, and timothy hay is the standard of excellence with which all other hays are compared. It is usually considered and treated as a short-lived perennial, and hence is the best grass to grow in a short rotation. However, for permanent meadow lands there are other species which continue to produce a heavy yield through a much longer period.

FIG. 1.—Timothy (*Phleum pratense*) grown in hard, dry soil.

Timothy succeeds best on moist loams and clays naturally rich in humus, or on those which have been heavily manured. It grows in the form of loose tufts, with few short root leaves, so that red top or red clover is usually sown with it to furnish a heavy bottom growth of leaves. Timothy hay is heavier in proportion to its bulk than many other grasses, and hence is richer, but there are others which contain a larger percentage of muscle-making elements, thus furnishing a more nearly balanced ration. The amount

of starch and other fat formers in clean, bright timothy hay is very large, and where it is mixed with red clover the two together make a complete food, the excess of fat formers in the timothy offsetting that of muscle makers in the clover. A sufficient amount of seed must be sown to obtain, as nearly as possible, a good and complete stand, and it is better to make a mistake on the side of using too much than to use too little seed, especially when starting a permanent meadow.

Good timothy seed weighs about 48 pounds to the bushel, and is of a light gray color, becoming darker with age or exposure to the weather. The amount of seed ordinarily sown ranges from 8 to 16 quarts to the acre, when sown alone. If sown with red clover, the amounts range from 6 to 8 quarts of timothy and 8 to 10 pounds of clover seed per acre. On rich and well-prepared land, which is capable of sustaining the maximum number of plants and of producing the maximum crop, a much heavier seeding should be used, ranging from 15 to 20 quarts of timothy if sown alone, or from 10 to 15 quarts of each of the grasses used in mixture. A Connecticut farmer whose success in growing hay is well known recommends 14 quarts of timothy and 14 quarts of red top as the best mixture. With such a seeding and with the ground in perfect tilth and thoroughly freed from weeds, from 4 to 6 tons of hay per acre is not an extraordinary yield, that being double or treble the quantity which is usually grown on land with only ordinary preparation and seeding. For seed, timothy should be cut about the time the heads turn color. In some of the prairie States, where the growing of timothy seed is one of the principal industries, the grass is cut with a twine binder, in the same manner as small grain, and this process has been recommended for more extensive practice, because of the greater facility with which the crop may be handled.

Redtop (*Agrostis alba vulgaris*).—This grass is a native, ranging across the northern portion of the continent. In the North it is the standard grass for wet meadows. It has been determined as a result of experiments, notably at the Rhode Island Experiment Station, that redtop makes its best growth on sour soils; in other words, on soils showing a distinctly acid reaction. Redtop grows naturally on marshy meadows and is best suited for cultivation in such places. While the application of lime is often recommended as an improving preliminary treatment of land which is to be seeded down to meadow grasses, it has been found that redtop is an exception, and will not make a favorable growth upon soils which are neutral or alkaline.

There are a great number of forms or varieties, which differ in height, leafage, and the manner of growth, so that great variability may be expected. Opinions differ widely in regard to its value because of this diversity of forms. It is a perennial, provided with long creeping stems and underground runners, and is one of the best bottom grasses, bearing large numbers of fine root leaves. Because of this and its creeping habit of growth it is one of the best grasses to use in mixtures

with erect tufted species, such as orchard grass and timothy, filling in between the clumps and producing a continuous turf. The weight of the seed varies according to the quality from 8 to 30 pounds to the bushel, averaging perhaps not more than 10 or 12. Mixtures of redtop and alsike clover are largely used for low, wet meadow lands and pastures. The creeping habit of this grass makes it less liable to injury from trampling by stock than is the case with the tufted, bunchy grasses.

Red top, or certain forms of it, sometimes becomes a bad weed in cultivated land, because of its tendency to form stolons or creeping rootstocks, which are as difficult to entirely remove as are those of quack grass. In Scotland and the Norwegian countries redtop is placed in the same category as quack grass as a weedy pest, especially on cold, marshy soils; but it is to be remembered that it does not thrive on alkaline soil, and so may be destroyed by the application of lime to the land, changing the soil from acid to alkaline.

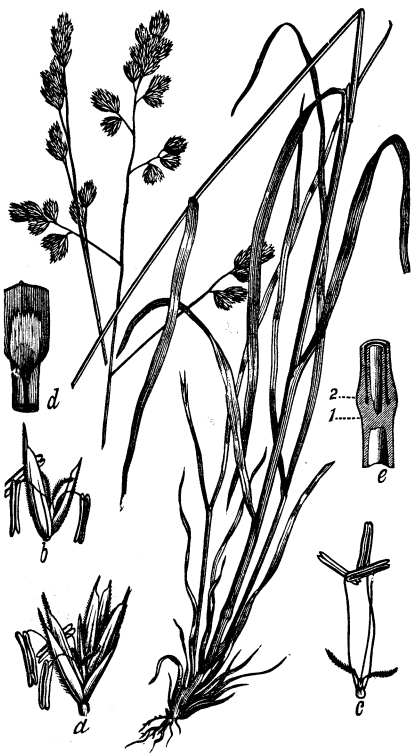

FIG. 2.—Orchard grass (*Dactylis glomerata*): *a*, spikelet; *b*, floret; *c*, pistil and stamens; *d*, base of leaf blade showing ligule; *e*, vertical section through a joint of the stem.

Orchard Grass, or Cock's Foot (*Dactylis glomerata*, fig. 2).—This is a deep-rooted perennial which forms cushion-like tufts that stand out prominently above the level of the turf. It is a strong, vigorous grower, thriving on rich alluvial and clayey soils. This grass is a native of central Europe, and has been cultivated for about one hundred years. On rich lands it makes a rapid and vigorous growth and comes to early maturity. Because of its habit of forming large cushions or tufts, it is ordinarily grown only in mixtures with bottom grasses, like redtop and red clover or alsike clover, whose leaves fill in the spaces between the bunches of orchard grass. The number of stems produced decreases after each cutting, and the plants become more and more leafy, so that the second crop is usually of finer quality, but more difficult to cure than the first. Because of its tufted habit and the ease with which it may be uprooted it is not a satisfactory pasture grass. Where orchard grass is sown in a permanent meadow the stand may be much improved by passing a heavy roller over the field when it is wet, thus pressing the bunches down into the ground and

making them less prominent. After each cutting the growth is very rapid. Because of the large number of long root leaves the aftermath is very nutritious. For hay, orchard grass should be cut at the time of first flowering, as after that the stems rapidly become hard and woody and unpalatable. Orchard grass is one of the best shade-enduring grasses and may be planted to good advantage in woodland meadows and parks. The seed weighs from 12 to 16 pounds to the bushel, and from 2½ to 3 bushels must be sown per acre if sown alone, but if used in a mixture with other grasses or with clover, less is required.

Meadow Fescue (*Festuca elatior pratensis*).—Meadow fescue is a tufted grass, more spreading in habit than orchard grass, which has not been as extensively cultivated in this country as it deserves. In England it forms a large part of the best meadow hay. It is better for hay than for pasture on account of its tufted habit. It is a native of Europe, and was first introduced into cultivation about 1820, although its value as a forage plant had long been recognized. Meadow fescue grows best on rich, moist loams. It will not thrive or make a satisfactory growth on land that is either dry or deficient in humus, and should not be sown with any expectation of a satisfactory crop except on good soils. Unlike orchard grass, it is a slow grower, attaining its best development during the second and third years. The yield ranges from 1 to 1½ tons the first year to 4½ or 5 tons the second and third years on soils perfectly adapted to it. The seed weighs from 12 to 26 pounds to the bushel, according to quality, and about 3 bushels are required to the acre when it is sown alone. In mixtures it is customary to use from one-sixth to one-fourth meadow fescue.

Tall Oat-Grass (*Arrhenatherum elatius*).—This is a perennial species which grows in loose tufts and throws up an abundance of leaves and tall stalks. It is well adapted to rich upland soils, and when once well established is one of the best drought-resistant cultivated grasses. In Iowa and California its cultivation has been especially recommended on account of its ability to live through the hottest and driest seasons; but while valuable in mixtures, it is not suitable to plant alone unless grown for seed. The forage is bitter, and when green is not readily eaten by cattle, except where it occurs in small quantities mixed with other grasses. The hay, however, is of fine quality, and is relished by stock. It blossoms early, and should be cut as soon as the first blooms appear, because after flowering the stems become hard, woody, and indigestible. It is a deep-rooted grass, and requires deep and thorough preparation of the soil. Like alfalfa, it is quickly killed by standing water or bad drainage. It makes its heaviest growth the second year, and thrives better on southern exposure than on cold northern ones. It may be sown alone or in mixtures with other grasses. In mixtures the quantity of tall oat-grass should not exceed one-fifth of the total amount sown. The seed weighs about 10 pounds to the bushel.

Italian Rye-Grass (*Lolium italicum*, fig. 3).—This biennial grass is a native of southern Europe, which has been in cultivation about sixty years. It was introduced into this country about thirty years ago. It grows in broad, compact tufts, producing a large number of stalks from a single root. In northern Italy it is grown under irrigation, and from five to eight crops are cut each year. It will not, however, make such heavy yields except on warm, rich, moist soils.

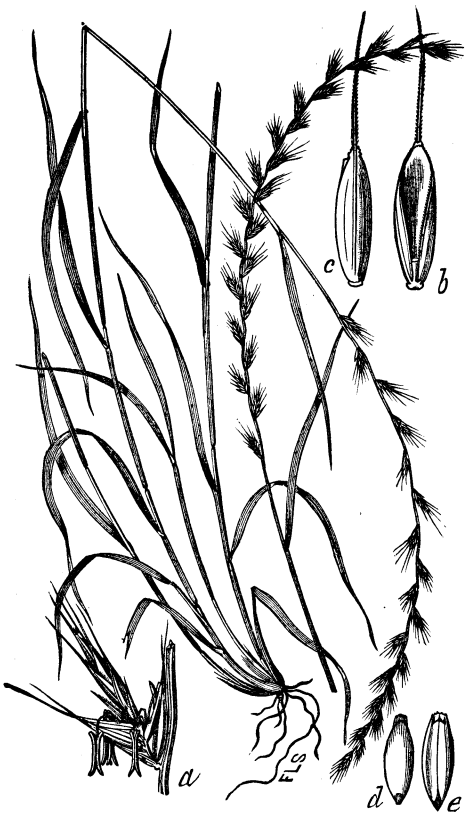

FIG. 3.—Italian rye-grass (*Lolium italicum*): *a*, spikelet; *b*, *c*, florets; *d*, *e*, front and back view of the seed.

While Italian rye-grass has been grown in many States with greater or less success, there is no doubt that it is beter adapted to the middle latitudes than to the extreme North or West. It grows to perfection from southern Pennsylvania to Virginia. There is no other grass which responds more rapidly to the use of fertilizers, especially barnyard and liquid manures. It is better suited to warm, deep, clay soils, rich in lime and humus, than to the lighter and drier sandy soils. This grass should always be cut for hay while in full bloom, as the stems rapidly become woody and unpalatable as the seed ripens. The seed of Italian rye-grass weighs from 14 to 20 pounds per bushel, and 60 to 80 pounds are required per acre. In eastern Maryland and Virginia this grass should be sown with red clover at the rate of 20 pounds of grass and 10 pounds of clover seed to the acre. Because of its very rapid growth, it is, like alfalfa, a good crop to rid land of weeds, as it quickly overtops and overshadows them, preventing them from ripening seeds.

PASTURE GRASSES.

For pasture grasses, Kentucky bluegrass, Canada bluegrass, perennial rye-grass, and redtop are used as follows:

Kentucky Bluegrass (*Poa pratensis*, fig. 4).—This native perennial is one of the best pasture grasses, and is largely employed for this purpose and for lawns in the Eastern and Middle States. It makes a good, firm sod, and is particularly well suited for turfing the slopes of terraces

and embankments where the soil is good. It is especially adapted to dry limestone soils, but will thrive on any good ground which is not too wet. Except for lawns, this grass should not be sown alone. It should enter largely into all mixtures for permanent pastures.

Canada Bluegrass (*Poa compressa*, fig 5).—This is a slender perennial, with much-flattened stems and extensively creeping rootstocks, forming a strong turf. The cultivated form is a native of Europe, which has become thoroughly naturalized throughout the eastern United States. It is closely related to Kentucky bluegrass. It attains its best growth on clay soils, and will thrive and make a better and closer turf than any other cultivated grass on dry and sterile clay knolls, along roadsides, and in barren fields. It withstands summer drought better than the Kentucky bluegrass, and is a very valuable species in dairy pastures. The seed should be sown only in mixtures with other species, excepting when used for laws, when it may be used alone at the rate of 3 or 4 bushels to the acre.

FIG. 4.—Kentucky bluegrass (*Poa pratensis*): *a*, spikelet; *b*, floret.

Perennial Rye-Grass (*Lolium perenne*, fig. 6).—This is a perennial, forming large and broad tufts, which, when a heavy seeding is used, interlace with one another and make a compact turf. It is a native of Europe, and is one of the oldest agricultural grasses, having been in cultivation more than 200 years. It grows best on stiff, wet soils and on heavy clays. On marshy lands where the soil is good it is one of the best pasture grasses. In such situations it will last from five to seven years, but on dry or sterile upland soils it is short-lived, rapidly disappearing after the second year. It stands pasturing well, making a quick recovery after having been closely cropped, and the quality of the herbage is very fine, being relished by all kinds of stock. The seed weights from 15 to 30 pounds per bushel, and 50 to 75 pounds should be sown per acre, according to the quality. This is one of the best grasses to use in mixtures on low, rich, marshy meadows.

The Bent Grasses.—Redtop, the closely related Rhode Island bent (*Agrostis canina*), and creeping bent (*Agrostis stolonifera*) are all of much value for lowland pastures. They are bottom grasses, suitable for using with tufted species. There are many forms and agricultural varieties which have originated as the result of growth on different kinds of soil. Some of these forms grow well on dry uplands, and others make a fine, close turf on wet meadows, even where accasionally submerged. They are hardy, make an early start in spring, and withstand heat and dry weather better than Kentucky bluegrass, and hence are better than the latter for lawns and pastures from the latitude of Maryland southward. The herbage is sweet and nutritious, and is relished by all kinds of cattle. Some of these grasses should be used in all pasture mixtures.

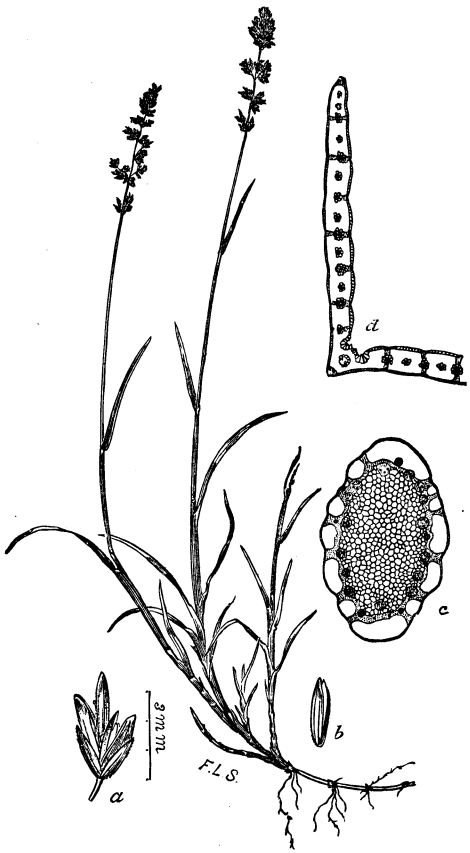

FIG. 5.—Canada bluegrass (*Poa compressa*): *a*, spikelet; *b*, floret; *c*, magnified view of cross section of flattened stem; *d*, magnified cross section of a leaf blade.

Red Fescue (*Festuca rubra*).—This perennial creeping grass grows along the Atlantic coast of the New England and Middle States and in the Northern States, extending westward to the Pacific. A great number of forms and varieties occur throughout its range. It makes a close, fine-leafed turf, and grows well on sandy fields and dry, sterile, sandy uplands. The seed weighs 14 pounds to the bushel, and it should be sown at the rate of 2½ bushels per acre alone, or a small amount in mixture with other grasses. This and orchard grass grow well in the shade and are good grasses to sow in woodland pastures.

THE CLOVERS FOR MEADOWS AND PASTURES.

For meadows and pastures the following clovers will be found of value:

White Clover (*Trifolium repens*).—This well-known biennial, or perennial, creeping clover should always be sown in either permanent or temporary pastures. It is adapted to low meadows, especially where the surface soil is mellow and rich, but it will also thrive and furnish a

considerable amount of forage on the drier and more sterile upland soils, especially if they have been well prepared for the seeding. On a hard and shallow soil white clover does not ordinarily last more than two years, but on the richer and moister lands it will grow for many years without reseeding. The herbage is sweet and contains a large per cent of muscle makers, there being upward of 14 per cent of crude protein in the dry hay. The seed is smaller than that of red clover, weighing about 63 pounds to the bushel, and 10 pounds will seed an acre. However, it is never advisable to sow it alone, and the amount used in mixtures varies from 1 to 3 or 4 pounds.

Red Clover (*Trifolium pratense*).—In the Eastern States this is the most extensively and commonly cultivated of all leguminous hay plants. Clover hay is the standard of excellence by which the feeding value of all other leguminous crops is measured. In common with other plants of the bean family, red clover has the property of taking nitrogen from the air by means of minute organisms which live in the small tubercles or swellings on its roots. It grows best on rich, warm loams containing humus. On stiff clays and loose sandy soils it is not so successful. Lime and potash are essential to its best development, and it is believed that the so-called "clover sickness," which prevents the successful growth of clover on the same field two crops in succession, is due to the removal by the clover of these plant foods from the soil. Red clover is usually sown with a grain crop, so that it will cover the field after the latter has been harvested. The seed weighs from 60 to 64 pounds to the bushel, and from 12 to 16 pounds are used per acre.

FIG. 6.—Perennial rye-grass (*Lolium perenne*): *a*, spikelet; *b*, *c*, florets, front and back view.

Alsike Clover (*Trifolium hybridum*).—This clover is well and favorably known and widely cultivated in mixtures for meadows and pastures, especially in low and wet marshy ones in the Middle and New England States. In the South it is not so successful, nor so highly valued. This clover will thrive where the soil is quite wet, and will even stand flooding without being killed, whereas red clover is quickly destroyed by stagnant water. The foliage is slightly bitter, and it is not relished by cattle as well as that of the red and white clovers. The

seed is much heavier than that of any of the other clovers, varying from 94 to 100 pounds per bushel. It is never advisable to sow this clover alone, because a better and larger amount of forage is produced when it is grown with grasses. Redtop and alsike are as much a standard mixture for wet meadows as timothy and red clover for the better and drier uplands.

Crimson Clover (*Trifolium incarnatum*, fig. 7).—This annual clover is a native of the Mediterranean region of Europe, and is of comparatively recent introduction into this country, in many sections having hardly passed the experimental stage. It thrives best on warm, loose, sandy soils, and does not make a satisfactory growth on stiff or wet and poorly drained clays, or on any of the heavier classes of soils. Its chief value is as a winter and early spring pasture crop and as green manure. The seed should be sown alone at the rate of 15 pounds to the acre about the middle of July or the first of August in the Middle and New England States, or later in the States farther south. Farmers have been more successful with it in the South than in those sections of the country where the winters are severe. From Maryland southward it is one of the best crops that can be grown for winter forage and green manure. It protects the soil from washing by the winter rains, and when plowed under in spring enriches the field by the addition of a large amount of organic matter containing nitrogen, that most valuable of all plant foods. It does not succeed far north, except on sunny slopes or where protected through the winter by a heavy snowfall.

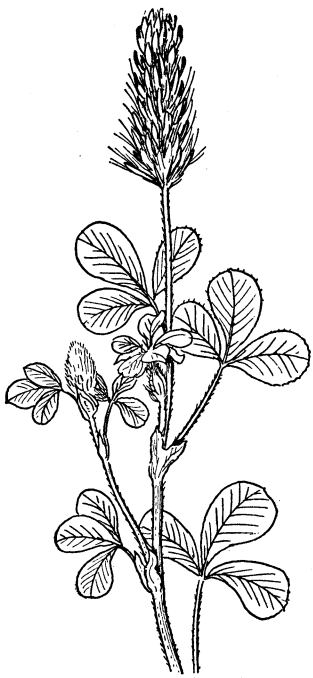

FIG. 7.—Crimson clover (*Trifolium incarnatum*).

Alfalfa, or Lucern (*Medicago sativa*, fig. 8).—This is a perennial, a native of Eastern Europe, which has been cultivated in the United States about seventy years, but it has not reached any prominence in eastern agriculture until within the last six or seven years. The acreage seeded to alfalfa is rapidly increasing as far north as Pennsylvania and central New York. The chief merit of alfalfa lies in the fact that it may be cut three or four times in a season. It is an excellent soiling crop and makes the best of hay when properly treated. The seed should be sown at the rate of 18 to 25 pounds to the acre about the middle of May, without a nurse crop. The soil must be deep, rich, well prepared, and well drained, neither underlaid by an impervious subsoil nor by a water table within less than 10 or 12 feet from the surface. For hay one crop may be cut the first year, and thereafter it should be mowed whenever it com-

mences to bloom. In the North it attains its maturity and makes its best growth from the third to the fifth year. It is an excellent crop to plant to rid a field of bad weeds, because of its rapid development and the possible frequent mowings. The hay is more difficult to cure than that of red clover, the leaves being more liable to shatter, but with care in handling and by curing the hay in cocks rather than in windrows an excellent quality and large quantity of hay may be secured. Alfalfa within certain limits is a good pasture plant, but the same precautions must be used as with any other clover or forage plant rich in muscle-making ingredients to prevent bloating of animals as a result of their gorging themselves. The cultivation of alfalfa is deservedly becoming more popular throughout the dairying region of the Middle and New England States, where its value as a soiling and hay crop is becoming generally recognized.

FIG. 8.—Alfalfa, or lucern (*Medicago sativa*): *a*, *b*, seed pod, side and end view: *c*, seeds, enlarged.

Sand Vetch, or Hairy Vetch (*Vicia villosa*, fig. 9).—Sand vetch, or hairy vetch, is an annual, a native of western Asia, and has been cultivated in this country and Europe for about fifty years. Seed was first brought to this country by the Department of Agriculture, and now its desirability as a forage crop has become established and it is being cultivated each year on a more and more extensive scale. There is often need of having some kind of green feed early in the season. Rye and winter oats furnish an acceptable bite for young cattle and milch cows, but both make their best growth on the heavier clays and loams. The vetches are an excellent crop to plant for the same purpose on the lighter and drier sandy soils. The seed weighs 60 pounds per bushel. It should be sown at the rate of from 4 to 6 pecks per acre, broadcast or in drills, from August 15 to October 1, and with it, as a supporting crop to raise the vines up off the ground, there should be planted from 2 to 4 pecks of winter wheat, oats, or rye. Using the larger amounts of seed, from 10 to 15 tons of green forage per acre may be cut about the middle of April or the 1st of May. It should be cut while the vetch is in full bloom. The yield of hay ranges from 1½ to 4 tons per acre, according to the fertility of the soil.

In the North the sand, or hairy, vetch is seldom grown as winter forage because of the severity of the season. It may be planted in spring in order to supply an early green crop for soiling purposes, or in midsummer for late autumn forage.

SOME GRASS MIXTURES.

The question of what grasses to use in a pasture or a hay mixture is hard to answer. There are so many valuable grasses and so many different kinds and conditions of soil that fixed formulas for the preparation of seed mixtures can not be employed. In the case of a meadow the farmer must combine those grasses and clovers which blossom and mature at about the same time. If a large proportion of tufted or bunchy grasses are used, bottom grasses of more spreading habit must be intermingled so as to fill the spaces and make a compact, even growth of herbage. It is also desirable to use those kinds which will make a rapid growth after each cutting. If clover and grass seeds are planted together the hay product will have a higher feeding value than that of either alone. These are only a few of the points that must be considered in making up a good hay mixture.

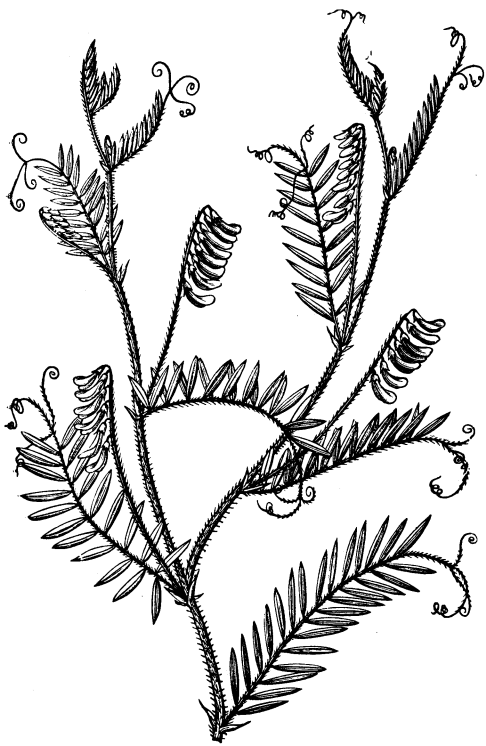

FIG. 9.—Sand vetch, or hairy vetch (*Vicia villosa*).

For a pasture mixture the chief requisite is not that all the kinds should mature at the same time, but that early, medium, and late should be used together, so as to furnish continuous grazing the entire season. Tufted grasses must be used only in small proportion for pastures. Their places must be taken by the turf formers with their interlacing mat of underground runners.

All kinds of farm stock enjoy a varied ration, and the hay and grazing will be relished more and prove more nutritious when the meadow consists of several sorts instead of only a single kind.

Throughout the northeastern States and in general where timothy and clover will thrive these form by far the best mixture to have for

a meadow. If the field is wet it is an advantage to add redtop. Under particular conditions or in particular localities it may be an advantage to sow along with these orchard grass, meadow fescue, or tall oat-grass. This is especially the case on the lower lands of Virginia and North Carolina, where timothy and clover do not thrive.

For pasture the above is quite satisfactory, and a meadow is often used as a pasture after the second or third year, as it has then usually passed its prime for hay. Throughout most of the region included in this discussion Kentucky bluegrass thrives and should form the basis of all pasture mixtures. This grass always comes in spontaneously in a few years, but where pasturing is intended from the first it should be sown in the original mixture. Canada bluegrass is also entirely satisfactory, as it is hardy and very nutritious. It is well to mix some white clover with either of these, and in moist spots a small quantity of alsike may well be added. If the pasture is started in the fall, it is well to add Italian or perennial rye-grass, as these make a vigorous early growth and will furnish much pasture the first fall and winter, especially in the more southern portions of the region.

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